configured to generate 20 kHz signals suitable for, e.g., hematocrit measurements of blood samples.

[0260] In one particularly preferred embodiment of the cartridge reader configured to perform luminescence based assays, the cartridge reader may employ an optical detector **2335**, e.g., a photodiode (most preferably, a cooled photodiode), photomultiplier tube, CCD detector, CMOS detector or the like, to detect and/or measure light/luminescence emanating from the read chambers. If a cooled photodiode is employed, a thermo-electric cooler and temperature sensor can be integrated into the photodiode package itself providing for selective control by the electronic control system.

[0261] A computerized control system **2310** is preferably utilized to selectively control operation of the cartridge-based system. The computerized control system may be fully integrated within the cartridge reader, separated from the cartridge reader in an externally housed system and/or partially integrated within and partially separated from, the cartridge reader. For example, the cartridge reader can be configured with external communications ports (e.g., RS-232, parallel, USB, IEEE 1394, and the like) for connection to a general purpose computer system (not shown) that is preferably programmed to control the cartridge reader and/or its subsystems. In one preferred embodiment, a single embedded microprocessor may be used to control the electronics and to coordinate cartridge operations. Additionally, the microprocessor may also support an embedded operator interface, connectivity and data management operations. The embedded operator interface can preferably utilize an integrated display **2360** and/or integrated data entry device **2355** (e.g., keypad). The computerized control system may also preferably include non-volatile memory storage for storing cartridge results and instrument configuration parameters.

[0262] **FIG. 34** shows a cutaway exploded view of one preferred design for reader **2300** and also shows a cartridge drawer **2386** (preferably comprising an integrated cartridge heater) on linear guide **2384** and driven by motor **2380** for moving the cartridge in and out of the reader. **FIG. 34** also shows fluid sensor array **2388** (holding sensors, preferably optical) for detecting fluid at selected positions in the cartridge and a motor

[0263] **2382** for bringing the cartridge together with frame **2383** which supports the electrical connectors (not shown in this view), fluidic connectors (not shown in this view), ampoule breaking mechanism **2350** and light detector **2335**.

[0264] **FIG. 24** illustrates a preferred configuration of valves in a cartridge reader fluidic handling sub-system configured for use with cartridge **2500** (analogous to cartridge **1400**) shown in the fluidic diagram of **FIG. 25** (along with preferred locations for cartridge reader fluid detection sensors **1-15**). The sub-system comprises a pumping system that comprises a pneumatic pump (preferably, an air piston) linked to a pump manifold. The manifold is connected to control lines (comprising control valves **2412**A and **2412**B) that connect the pump to selected vent ports (preferably, the waste chamber A vent port **2512**A and waste chamber B vent port **2512**B) on a cartridge and allow the pump to be used to move fluid in the cartridge away or towards the selected vent ports.

[0265] The manifold is also connected to a pump vent line (comprising a pump vent line valve **2492**) for venting the pump manifold. The control valves have a closed position that seals the control line and the associated cartridge vent port, an open position that connects the pump to the cartridge vent port and, optionally, a vent position that opens the cartridge vent port to ambient pressure. The pump vent line valve has a closed position that seals the pump vent port and an open position that exposes the pump manifold to ambient pressure and releases pressure/vacuum in the pump manifold. The fluidic handling sub-system further comprises vent lines (comprising vent valves **2412**, **2422**, **2432**A and **2432**B) that allow venting of vent ports (sample chamber vent port **2512**, air port **2522**, reagent chamber A vent port **2532**A and reagent chamber B vent port **2532**B, respectively) on a cartridge (preferably, the cartridge vent ports other than the waste cartridge ports). The vent valves have a closed position that seals the associated cartridge vent port and an open position that exposes the vent port to ambient pressure. The fluidic handling sub-system may also comprise a pressure sensor couple to the pump manifold for detecting pressure in the manifold. During fluidic control of a cartridge, the pressure in the manifold is, preferably, monitored to ensure that it falls within expected pressure ranges for specific operations and confirm that the fluidic handling system is operating properly. The specific preferred valve configuration shown in **FIG. 24** is designed to move fluid primarily by aspirating it towards the valve chambers. Other valve configurations, e.g., configurations that drive fluids primarily by positive pressure, will be readily apparent to the skilled artisan and may valves that allow chambers other than the waste chambers to be connected to the pump and/or that allow the waste chambers to be directly vented to the atmosphere.

[0266] With reference to **FIGS. 24 through 26**, performance of an assay using a preferred cartridge of the invention will be described. This exemplary method will be described in the context of a two-step multiplexed binding assay using antibodies as binding reagents and ECL as the detection methodology, however, it will be readily apparent to the skilled practitioner that the described fluidic operations can be used in a variety of different assay formats (e.g., binding assays using other classes of binding reagents, enzymatic assays, etc.) and with a variety of different detection technologies. It is also apparent that the sequence of operation discussed below may vary according to differences in the configuration of a particular cartridge as well as differences in the particular assay to be performed.

[0267] During operation, the pump vent line valve may be used to enable and disable pressurization of the system for more precise fluid control; when the pump's vent is opened, the system returns to ambient pressure very quickly. Typical fluid draw operations, i.e., routing of fluid within and throughout the fluid network, involve closing the pump vent valve and opening i) one or more (preferably, one) cartridge vent valves, e.g., the sample, air, reagent chamber A and/or reagent chamber B vent valves and ii) one or more (preferably, one) control valves, e.g., waste chamber A or waste chamber B control valves. Therefore, a slug of fluid will move along a path through the fluid network in the cartridge when the fluid channels comprising that path is vented to air at one end and subjected to either pressure or vacuum at the other end.

[0268] A user selects the appropriate cartridge for carrying out a desired measurement and introduces sample to the